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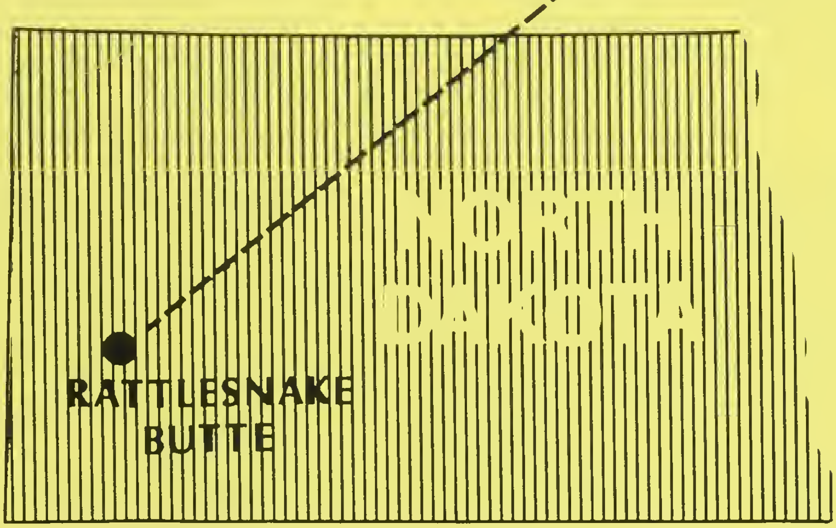
Rattlesnake Butte Study Area Report



RESOURCE & POTENTIAL RECLAMATION EVALUATION

SUMMARY

Rattlesnake Butte Study Area Report
Published June, 1982

The Federal Coal Management Program has been designed as an interagency cooperative effort to meet national energy objectives.

Rattlesnake Butte Study Area Report was prepared through the efforts of the U.S. Department of the Interior, principally the Bureau of Land Management, Geological Survey, and Bureau of Reclamation.* The study effort began in 1978 and was concluded in 1982 with the publication of this report.

The area described in this report has been tentatively determined to be a potential Federal coal development area. The purpose of this report is to provide information on the area's reclamation potential, should coal development occur. This report will assist managers in making final Federal coal leasing decisions.

Limited copies of this report are available from:

Bureau of Land Management
Montana State Office
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Billings, MT 59107

Please reference the title and report numer 22-78 when making a request for this report from the Bureau of Land Management.

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		Newell/28, MT	50-78

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*In May of 1981, the Secretary of the Interior approved changing the Water and Power Resources Service back to its former name, the Bureau of Reclamation. All references in this publication to the Water and Power Resources Service should be considered synonomous with the Bureau of Reclamation.

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15. Supplementary Notes

Prepared jointly by Bureau of Land Management, Bureau of Reclamation, and Geological Survey.

16. Abstract The purpose of this investigation was to collect baseline data for establishing reclamation objectives and lease stipulations. The report includes data on climate, physiography, geology, coal resources, and overburden. The study area, located in Southwestern North Dakota, lies within the unglaciated portion of the Great Plains Physiographic Province. Climatic conditions are characterized by cold winters, warm summers, and large variations in seasonal precipitation. Average annual precipitation is 15.5 inches; the frost-free season averages 122 days. Bedrock exposed along deeply-incised drainages and in the uplands is the Sentinel Butte Member of the Paleocene Fort Union Formation. Surface-minable resources in three lignite beds, which range in thickness from 1.4 to 18 feet, total 484 million tons. Of this, 128 million tons is in beds more than 10 feet thick under less than 200 feet of overburden. Coal rank is Lignite A to B. Most soils in the study area should yield 6 to 12 inches of topsoil which is nonsaline, nonsodic, and permeable. Available subsoil materials appear fair to poor in quality due to high salinity, sodicity, and/or clay content. Only 3 percent of the bedrock samples from 15 USBR drill holes were rated suitable for use as supplemental plant media; 7 percent were of limited suitability; and 90 percent were unsuitable. Excessive exchangeable sodium was the major limiting factor. Based on the resource data in this report, the potential for restoring surface-mined land in this study area to a condition capable of supporting the present uses (rangeland, hayland, cropland) appears good.

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0807 Coal Deposits
1407 Reclamation

b. Identifiers/Open-Ended Terms

North Dakota, surface-mined land, reclamation potential, soils, vegetation, geology, geomorphology, hydrology, climate.

c. COSATI Field/Group

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RESOURCE AND POTENTIAL RECLAMATION EVALUATION
OF
RATTLESNAKE BUTTE STUDY AREA
DICKINSON COALFIELD
NORTH DAKOTA

INTRODUCTION

Recent energy shortages have forced our society to seek new domestic sources. Attention has focused on the immense quantities of low sulfur coal that lie within the Rocky Mountain and Northern Great Plains regions. It is the responsibility of the Department of the Interior and principally the Bureau of Land Management to assist in meeting these energy demands and, at the same time, provide sound reclamation guidelines so that the disturbed lands are restored to an acceptable condition.

PURPOSE

The purpose of this report is to provide information for establishing reclamation objectives and lease requirements. Detailed data is given on geology, coal resources, and overburden (soil and bedrock). Less detailed information is provided on climate and physiography.

GENERAL DESCRIPTION

LOCATION

The Rattlesnake Butte Study Area is located in southwestern North Dakota in parts of Stark, Billings, and Dunn Counties. Plate 1 shows the general location. The study area includes approximately 13,070 acres in all or parts of secions 2, 4, 6, 8, 10, 14, 18, 20, 22, 26, 28, 30, 32, and 34, T. 140 N., R. 98 W.; sections 2, 10, 12, 14, 22, 24, 26, 30, and 34, T. 140 N., R. 99 W,; section 32, T. 141 N., R. 97 W.; and sections 32 and 34, T. 141 N., R. 98 W. The USBR land classification study was expanded to include about 2,250 additional acres along the north edge of the study area in all or parts of section 30, T. 141 N., R. 97 W.; and sections 26, 28, and 30, T. 141 N., R. 98 W. Photograph 1 shows the complete study area including the additional sections covered by the land classification study. Plate 2 shows the area topography. All surface is privately owned. All coal is federally owned as shown on Plate 3.

CLIMATE

The Rattlesnake Butte Study Area has a continental-type semiarid climate characterized by harsh cold winters, warm summers, and large variations in seasonal precipitation.

PRECIPITATION

The mean annual precipitation in this area is approximately 15.5 inches, based on data recorded at Dickinson, North Dakota (about 20 miles east of the study area). More than 75 percent of the annual precipitation occurs

during the growing season, April through September. As much as 10 inches may fall in June, which is commonly the wettest month. Most of the precipitation falls during thunderstorms.

TEMPERATURE

The average annual maximum and minimum temperatures for this area (recorded at Dickinson) are $54^{o}F.$ and $28^{o}F.$, respectively. Generally, about 22 days each year have a maximum temperature over $90^{o}F.$, but a maximum temperature exceeding $100^{o}F.$ occurs only 2 to 3 days a year, and in some years not at all. In an average year, about 46 days have a minimum temperature of $0^{o}F.$ or lower.

Based on data recorded at Dickinson, the average length of the frost-free ($>32^{o}F.$) period in this area is estimated at 122 days between mid-to late-May and mid- to late-September. However, by mid-July, the available soil moisture is usually depleted and the plants mature or become dormant.

OTHER CLIMATIC FACTORS

On the average, thunderstorms occur on 30 to 35 days each year, and hail generally falls on 2 or 3 of these days. Hailstorms are most common between May and August.

Winds that erode unprotected soils occur 34 percent of the time, primarily during April, May, and June. Wind speeds of greater than 47 miles per hour have not been recorded in this area.

This area receives approximately 60 percent of the sunshine that could possibly occur each year.

EFFECT OF CLIMATE ON REVEGETATION

Most climatic factors in the Rattlesnake Butte Study Area appear favorable for revegetation of surface-mined land with native range plants, small grains, or other adaptable crops. However, several hazardous climatic factors which may adversely affect revegetation efforts in the area should be recognized. These are: (1) below normal or uneven distribution of precipitation, especially during the growing season, (2) severe thunderstorms or hailstorms that cause crop damage and soil erosion, (3) late spring freezes, and (4) soil erosion and moisture depletion by wind.

Spring is the most favorable planting time in this area since soil moisture is generally high during the early part of the growing season. The spring rains usually provide moisture to the soil in excess of the plant moisture requirement. With favorable soil moisture and temperature conditions, spring-planted grasses should germinate rapidly and become established before the available soil moisture is depleted in mid-July.

PHYSIOGRAPHY

The Rattlesnake Butte Study Area lies in the unglaciated Missouri Plateau section of the Great Plains Physiographic Province. This section is characterized by a series of complex, narrow divides which are the eroded remnants of a once widely extensive plateau.

The topography of this study area is variable, ranging from nearly level and gently sloping stream terraces, fans, and footslopes to steep, rolling uplands. Sedimentary strata of the Fort Union Formation (Sentinel Butte Member) are exposed along deeply-incised drainage channels and, to a lesser extent, at higher elevations in the uplands. Wind-worked sandy deposits are also notable at higher elevations in the uplands. Resistant scoria (baked shale) outcrops are common throughout this study area. These outcrops appear as thin, remnant "caps" over gentle and moderately sloping uplands.

The relief in this study area is approximately 260 feet, ranging from 2470 feet along North Creek in the southeast corner of the study area to 2730 feet in the uplands.

Drainage of the study area is accomplished through an extensive network of branching drainages (dendritic pattern). The majority of the area drains southeastward to the Heart River via North Creek and its tributaries. The northern portion of the study area drains in a northwesterly direction toward Green River.

GEOLOGY

The Rattlesnake Butte Study Area lies within the Williston Basin of west-central North Dakota.

Bedrock is of Paleocene Age and belongs to the Sentinel Butte Member of the Fort Union Formation. It mostly consists of soft shale and sandstone with lesser amounts of siltstone and lignite.

Thirteen lignite and/or lignitic shale beds were penetrated by drilling in the area. Two coalbeds are of primary economic significance. They are the IV and VIII Coalbeds. In previous reports they have been named respectively the "E" or Heart River Coalbed and the "D" or Fryburg Coalbed. Both coalbeds vary considerably in thickness from one part of the study area to another and each averages over 8 feet thick. Overburden is generally less than 200 feet thick over each bed.

Engineering property tests were not conducted on bedrock samples from the Rattlesnake Butte Study Area, but results should be similar to those for comparable material at the Otter Creek Study Site, Montana. Those tests revealed that shear strengths of the material are low, especially in a saturated condition. Slides can easily develop adjacent to high walls in

surface mines, primarily along beds of weak, plastic, carbonaceous shales. Saturated alluvial deposits and uncemented siltstones and fine-grained sandstones will readily erode and flow into excavations.

Excavation slopes will vary between minesites and will be dependent on exposure time, moisture conditions, material types, and depth of cut. Adequate drainage will have to be maintained to relieve pore water pressure in the overburden, and excavation below the water table will be limited until the material is drained.

Studies at the Otter Creek Site indicate that disturbed overburden should have slopes not greater than 4 to 1 and berms of 50 to 100 feet in width designed on the slope surface.

Volume changes in the overburden will occur with disturbance. An increase in volume of about 25 percent should be expected. In some cases the surface of the replaced overburden will be higher than the ground surface before mining.

Three types of instability are common on reclaimed coal-mined areas in the Northern Great Plains. They are: (1) areawide settling, (2) localized collapse, and (3) piping. Each form of instability is affected by certain variables in the postmining landscape. These variables include the physical and chemical characteristics of the overburden, the methods and equipment used in stripping and contouring operations, and the season when these activities occur. One or more of these types of landscape instability may occur on reclaimed land in the Rattlesnake Butte Study Area.

Weathering tests performed on bedrock samples from the study area revealed that shales break down more rapidly than either sandstones or siltstones, but the material produced may be difficult to move and place because of its plasticity.

Most types of earth materials for construction uses are available in the study area. Only concrete aggregate and high quality riprap will probably have to be obtained from outside of the study area.

The Rattlesnake Butte Study Area lies in a stable seismic region, and no significant earthquake damage has been experienced in the past.

COAL RESOURCES

The Rattlesnake Butte EMRIA study site is located in the Dickinson coalfield in the central part of the Williston Basin, southwest North Dakota. This area contains surface-minable resources in three lignite beds that range in thickness from 1.4 to 18 feet, in the Tongue River and Sentinel Butte Members of the Fort Union Formation of Paleocene Age.

Resources of lignite in the three beds total 484 million tons (439 million metric tons). Of this amount 26 percent or 128 million tons is in beds more

than 10 feet thick that are under less than 200 feet of overburden. Measured resources total 55.7 million tons (50.5 million metric tons), indicated resources total 233 million tons (211 million metric tons), and inferred resources total 196 million tons (178 million metric tons).

The apparent rank of the coal ranges from lignite A to lignite B. The average heat of combustion of 19 core samples from the site on the as-received basis is 5600 Btu/lb (3110 kcal/kg), average ash content is 10.6 percent, and average sulfur content is 1.0 percent.

OVERBURDEN - SOIL AND BEDROCK

PRINCIPAL SOIL BODIES

Soils of the Rattlesnake Butte Study Area can be placed in two major categories based on their mode of development, landform position, and parent material. They are: (1) residual soils on uplands developing in weathered sandstone, siltstone, shale, and baked shale (scoria), and (2) alluvial/colluvial soils on fans, footslopes, swales, and terraces forming in loamy alluvial/colluvial deposits. The soft sedimentary strata of the Sentinel Butte Member, Fort Union Formation, have provided the parent materials for both major soil categories. The residual soils occur over approximately 85 percent of the study area; the alluvial/colluvial soils occupy about 10 percent of the area; and minor soil inclusions, i.e., wind-deposited soils, occur on only 5 percent of the area.

Four types of residual soils were identified on the basis of their parent material and textural composition. These are: (1) moderately coarse and coarse-textured soils developing over soft sandstone, (2) medium-textured soils forming over siltstone and silty shale, (3) medium-textured soils developing over baked shale, and (4) moderately fine to fine-textured soils forming over shale.

The moderately coarse and coarse-textured residual soils developing over softly consolidated sandstone occupy gentle to steep upland slopes. The depth of these soils is variable, ranging from less than 10 inches (.25 m) to greater than 60 inches (1.5m). Permeability is moderately rapid in these soils and moisture retention appears adequate to support the growth of native range plants. These soils are nonsaline and nonsodic.

The medium-textured residual soils forming over siltstone and silty shale occur in upland areas on gentle to steep slopes. Depth of these soils ranges from less than 10 inches (.25 m) on steep slopes to more than 60 inches (1.5m) on gentle slopes. Permeability is usually moderate in the surface horizon and moderately slow in the finer-textured subsurface horizons. Available moisture for plant use is moderately high. The surface layer is nonsaline, the subsurface layers are moderately to strongly saline.

The medium-textured soils developing over baked shale occur on gentle to moderate upland slopes. They are shallow to very shallow (3 to 18 inches-

.08-.46 m) over fractured bedrock. Permeability is moderately rapid in these soils and available moisture retention is moderately low. These soils are nonsaline and nonsodic.

The moderately fine to fine-textured soils forming over shale occupy nearly level to steeply sloping, hilly uplands. Depth ranges from less than 10 inches (.25 m) to greater than 30 inches (.76 m) over alkaline shale. Infiltration of precipitation into these soils is slow, resulting in excessive runoff and erosion. Permeability is also slow, particularly in the clayey substratum. Available moisture retention is moderately high. The surface layer is slightly to moderately saline; the subsurface layers and substratum are moderately to strongly saline and alkaline (sodic).

The alluvial/colluvial soils were subdivided into three groups on the basis of landform position, period of deposition, and physical/chemical characteristics. These are: (1) young alluvial/colluvial soils developing in recent deposits on gently sloping fans and footslopes and in the bottom and adjacent to intermittent streams, (2) mature alluvial/colluvial soils forming in ancient deposits on gently to moderately sloping upland terraces and footslopes, and (3) alkaline alluvial/colluvial soils developing in sodium-affected deposits on gently sloping terraces and footslopes.

The young alluvial/colluvial soils are usually moderately deep and well drained. Textures range from loam to loamy sand. Permeability is moderate to moderately rapid, depending on the texture. Available moisture ranges from moderate (loams) to moderately low (loamy sands). These soils are nonsaline and nonsodic.

The mature alluvial/colluvial soils are typically deep and well drained. Textures vary from medium to moderately coarse. Permeability is moderately rapid in these soils. The moisture available for plant use is moderate. These soils are nonsaline and nonsodic.

The alkaline alluvial/colluvial soils are generally deep and somewhat poorly drained. Textures are typically medium in the surface horizon and moderately fine in the subsurface horizons. Permeability decreases from moderate in the surface layer to moderately slow in the subsurface layers and substratum. Available moisture retention is moderately high. The surface layer is usually slightly saline and moderately alkaline; the subsurface layers and substratum are strongly saline-sodic (strongly alkaline).

LAND SUITABILITY CLASSIFICATION

A semidetailed land suitability classification of the Rattlesnake Butte Study Area was made to evaluate and characterize the overburden (soil and bedrock to a depth of 10 feet) as a source of material for resurfacing and revegetating the area if it is surface-mined. This classification provides data on the quantity and quality of material for revegetation and ease of stripping and stockpiling the usable material.

Four land classes: 1, 2, 3, and 6 were established to group land of equal suitability for the specific use of revegetation. Class 1 lands provide the most desirable and plentiful source of easily stripped revegetative material. Land in this class may have surplus suitable material that can be utilized in deficient areas. Class 2 lands have adequate supplies of resurfacing material, but it is generally of lower quality than Class 1 or somewhat difficult to strip. Class 3 lands are marginally suitable, but can generally meet the planting media needs for their revegetation. Class 6 lands lack adequate quantities of suitable material to meet the needs for revegetation. If these lands are disturbed by surface mining, it will be necessary to borrow material from areas with adequate supplies or modify the material available for revegetation.

The results of the land suitability classification of the Rattlesnake Butte Study Area expressed as a percentage of the area are as follows: Class 1 - 8.6, Class 2 - 19.3, Class 3 - 69.5, and Class 6 - 2.6.

OVERBURDEN SUITABILITY FOR REVEGETATION

Soil Mantle Suitability

Based on the field and laboratory data obtained from the land suitability classification, it appears that most of the residual and alluvial/colluvial soils in this study area should yield about 6 to 12 inches (.15-.30m) of good quality topsoiling material for revegetation. This material, which generally includes the A and upper portion of the B horizons, is typically nonsaline, nonsodic, and permeable.

Many of the soil profiles show a marked increase in soluble salts, exchangeable sodium, and/or clay content below 12 to 18 inches (.30-.46m) in depth. Therefore, a significant percentage of the available subsurface materials in this study area were classified as fair or poor for placement below the primary plant rooting zone in reconstructed profiles.

Permeable material that is moderately saline may be utilized in areas lacking fair or good quality subsurface material. This material should leach and reclaim readily if placed over spoils with good internal drainage characteristics. Sodic and/or clay-rich materials should be selectively placed well below the plant rooting zone in reconstructed profiles.

Bedrock Suitability

A systematic evaluation was made of core samples from Bureau of Reclamation Drill Holes 78-101 and 102 and 79-103 through 115 in order to determine suitability of the materials for use as plant media.

A complete set of laboratory data, including selected trace element determinations, provided the data base necessary to evaluate the core materials. Suitability criteria were applied to the laboratory data in order to place the bedrock materials into one of three classes: Suitable, Limited Suitability, or Unsuitable.

Overall, approximately 3 percent of the bedrock materials were rated Suitable for use as plant media, 7 percent were of Limited Suitability, and 90 percent were Unsuitable. Excessive exchangeable sodium was the major limiting factor for the samples classified as Limited Suitability or Unsuitable. Other limiting factors included high levels of soluble salts, high clay or sand percentages, high pH, and high concentrations of trace elements (surface samples from DH-79-104 and DH-79-107 had very high lead levels).

Ideally, bedrock materials containing excessive levels of soluble salts, sodium, and/or trace elements should be covered by a minimum of 4 feet of nontoxic overburden during the reclamation operation in order to alleviate any hazard associated with plant reestablishment. Although topsoil/subsoil quantity and quality appear sufficient for plant reestablishment in this study area, this bedrock suitability evaluation indicated that a 4-foot covering of nontoxic overburden may not be achievable. More detailed premining investigations will be necessary to more accurately quantify the available nontoxic overburden in this study area.

SOIL INVENTORY

This section was incorporated into the main report in order to provide additional data on the soils occuring in the Rattlesnake Butte Study Area. The primary source of the information presented in this section was the Soil Survey of Stark County, North Dakota (USDA - Soil Conservation Service, 1968).

The following data is included in the main report:

1. A Soil Inventory Map of the Rattlesnake Butte Study Area showing the soil types/complexes/associations mapped by the Soil Conservation Service.

2. Soil Series Descriptions - National Cooperative Soil Survey.

3. Interpretations for selected soil uses.

4. Engineering properties of the soils.

5. Erosion Evaluations (BLM Form 7310-12) correlating with USBR Point Site soil profiles.

Note - Soil Survey data (SCS) was unavailable for sections of the study area located in Billings and Dunn Counties, North Dakota; therefore, this data was not included in the main report.

RECOMMENDATIONS FOR RECLAMATION

INTRODUCTION

Should surface mining occur in the Rattlesnake Butte Study Area, the coal mine operator will be required to restore all disturbed areas "in a timely manner to conditions that are capable of supporting the uses which they are capable of supporting before mining, or to higher or better uses . . ." (Chapter 38-14.1, Section 69-05.2-23-01, North Dakota Century Code).

Unless an alternative postmining land use is desired by the landowner(s) and approved by the North Dakota Public Service Commission, the main objective of reclamation will be to restore the mined land to a condition capable of supporting the uses that it supports today. These uses are rangeland, hayland, and cropland (small grains, corn, sunflowers).

STABILITY OF THE POSTMINING LANDSCAPE[1/]

The design of a stable postmining landscape in the Rattlesnake Butte Study Area will require the integration of several critical factors. These include: (1) a detailed knowledge of the distributuion of overburden materials, with emphasis on the delineation of highly sodic spoils, (2) proper equipment selection, and (3) a consideration of seasonal factors. For reclamation to be successful, consideration must be given to the entire landscape, not merely the soil zone.

Three forms of landscape instability are common on reclaimed coal-mined areas in the Northern Great Plains. These are areawide settling, local collapse, and piping.

Areawide settling is common in most postmining landscapes, but appears to cause only minimal disruption. This form of subsidence will probably be most pronounced during the first year following reclamation and will continue at a decreasing rate for a number of years. The two major factors influencing areawide settling are: (1) texture of the overburden, and (2) equipment used in spoil contouring operations.

A significant quantity of overburden in the Rattlesnake Butte Study Area consists of fine-textured material (shale). When disturbed, this material usually results in more blocky and, initially, more porous spoils than does coarse-textured overburden (sandstone). Therefore, a greater degree of areawide settling may be expected in this area as compared to an area where coarse-textured materials are predominant.

Equipment used in contouring operations is a critical factor influencing areawide settling. Settlement is a significantly less in scraper-contoured areas than in dozer-contoured areas due to the fact that scrapers more

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1/ Groenewold, G. H. and Rehm, B.W., 1980 (modified)

effectively break down large overburden blocks and compact the spoil mass. Therefore, the degree of areawide settlement may be reduced by employing scrapers rather than dozers in spoil contouring operations.

Local large-scale collapse often develops soon after contouring is completed. Development typically ends within 1 year. This form of instability is predominant in precontouring valleys where large, frozen spoil blocks are concentrated by mid-winter dozer contouring. Thawing of these blocks results in local surface subsidence. To restrict the development of local collapse features, the use of scrapers rather than dozers should be considered for contouring operations during the winter months.

Piping appears to be a severe and long-term problem in some postmining landscapes. This form of instability usually begins soon after contouring ceases and may continue for several years. In some postmining landscapes, piping has only started to develop after as much as 5 years.

Piping is apparently controlled by a combination of physical and chemical conditions in the spoils. All piping begins as a crack, either on the surface of exposed spoils or at the topsoil-spoil interface. In the latter case, the overlying topsoil collapses into the pipe and is carried away. Repeated topsoil application is usually unsuccessful in stopping the growth and development of piping. Cracking of spoils is restricted to areas of highly dispersive sodic materials. The cracks allow access for large volumes of surface runoff to flow into the subsurface of the spoils. However, surface cracking alone will not necessarily result in the development of piping. Piping will develop only if an avenue for water movement can result from fracturing within the mass of spoils due to settling between differentially compacted areas (i.e., scraper-contoured area adjacent to dozer-contoured area) or within areas of poorly compacted spoils (i.e., dozer contouring only).

Piping usually develops in nearly flat areas, where runoff is minimal and infiltration is maximized. Thus, the final surface slopes in reclaimed areas must also be recognized as controlling factors in the development of piping.

Given the proper conditions of slope, near-surface dispersive materials, and a permeable zone in the base of the spoils, piping may continue to develop and disrupt the restored landscape for many years. Selective placement of excessively sodic overburden encountered in this study area may prove to be the only effective means of controlling piping.

Because the postmining landscape in the Rattlesnake Butte Study Area will be unstable, structures should not be built unless they are specifically designed to absorb differential settlement. Also, reconstructed drainage channels will require periodic maintenance to ensure that ponded areas do not develop in areas of localized settling.

GRADING AND HANDLING OF SPOIL MATERIALS

Mine operators will be required by law to grade all disturbed areas "to the gentlest topography consistent with adjacent unmined landscape elements . . . ." All spoil shall be transported, backfilled, compacted (where advisable to insure stability or to prevent leaching), and graded to eliminate all highwalls, spoil piles, and depressions (Chapter 38-14.1, Section 69-05.2-21-01(2)(a), North Dakota Century Code).

Where possible, all final grading and preparation of graded land prior to the redistribution of topsoil should be conducted along the contour to minimize erosion and maximize landscape stability.

Present North Dakota law states: "Spoil materials that are found by the (Public Service) Commission to be excessively saline, sodic, or both, are considered to be toxic-forming materials and shall be covered with a minimum of 4 feet of nontoxic material, provided such material is available" (Chapter 38-14.1, Section 69-05.2-21-03(1), North Dakota Century Code). The results of laboratory tests performed on samples from 15 drill holes in the Rattlesnake Butte Study Area indicated that a significant number of the bedrock strata are excessively sodic. All samples from 5 of the 15 holes had high to very high levels of exchangeable sodium. In the remaining holes, most samples below 20 to 40 feet in depth were highly sodic. Based on this data, a 4-foot covering of nontoxic overburden over the entire study area may not be achievable. More detailed premining investigations will be necessary to accurately determine the location and quantity of available nonsodic overburden.

EROSION CONTROL

Reducing runoff and erosion and increasing the on-site conservation of moisture for vegetative establishment are feasible objectives for reclaimed land in the Rattlesnake Butte Study Area. The following procedure is recommended as a means toward achieving these objectives: (1) reduce the mean surface slope in the reclaimed area, (2) scarify the surface of the regraded spoils, (3) replace the subsoil/topsoil and prepare a seedbed, (4) conduct seeding and planting operations as soon as possible after topsoil redistribution, and (5) apply mulch to the newly seeded areas.

Reducing the mean slope in the reclaimed area will provide a more gently sloping landscape. A more level landscape will allow for an increase in infiltration and moisture retention and a decrease in runoff and sediment yield. The increase in moisture retention will be highly desirable for seedling establishment in the reclaimed area.

Prior to the redistribution of suitable plant growth material, the surface of the regraded spoils should be ripped or chiseled in order to eliminate slippage surfaces at the spoil-topsoil interface and provide a favorable

subsurface medium for air/water infiltration and root penetration. Ripping or chiseling should be conducted along the contour wherever possible to prevent runoff and ensure maximum stability.

Subsoil and topsoil are often compacted by heavy machinery during the redistribution process. These materials should be loosened by chiseling or other means prior to actual seedbed preparation (disking/harrowing). The loosened material will allow roots to readily penetrate its matrix and will also facilitate a higher rate of air/water infiltration. All tillage operations should be conducted along the contour to prevent excess runoff and substantial loss of the plant growth material.

Seeding and/or planting should be conducted as soon as possible after the topsoil has been spread and a seedbed has been prepared. The establishment of a permanent vegetative cover as quickly as possible will be the most effective method of controlling erosion in the reclaimed area. A temporary cover of small grains, grasses, or legumes may be required to protect the topsoil until such time as a permanent cover can be established.

Suitable mulch should be applied on all newly seeded areas to control erosion, conserve soil moisture, and enhance seed germination. The application of hay or straw mulch at a rate of about 2 tons/acre should be considered for the Rattlesnake Butte Study Area. To prevent substantial losses of the mulching material due to blowing, the hay or straw should be anchored (disked or crimped) to the soil surface.

REVEGETATION

Revegetation of surface-mined land in the Rattlesnake Butte Study Area will require: (1) removal, segregation, and redistribution of suitable plant growth material, (2) selection of adapted plant species, and (3) use of proper planting and seedbed preparation procedures.

Removal, Segregation, and Redistribution of Suitable Plant Growth Material

Prior to the actual mining operation, all suitable plant growth material should be removed and either redistributed immediately on regraded areas or segregated in separate stockpiles. North Dakota regulations require that both topsoil and subsoil be salvaged for replacement as plant media (Chapter 38-14.1, Section 69-95.2-15-02(2), North Dakota Century Code). This is accomplished in a 2-lift process with the most desirable plant growth material ("topsoil") being removed in the first lift and the remaining suitable material ("subsoil") being salvaged in the second lift. Based on the results of the Land Suitability Classification included in this report, it appears that 6 to 12 inches (.15-30 m) of fair to good quality topsoiling material can be removed in the first lift from most soils in this study area. The quantity and quality of subsoil material to be salvaged in the second lift is highly variable in this study area.

If stockpiling of the suitable plant growth material is necessary, the stockpiles should be selectively placed on a stable area and protected from erosion, compaction and contaminants (toxic spoils). Establishment of a quick growing vegetative cover on the stockpiles is probably the most effective method of protection; however, other measures such as snow fences, mulches, or chemical binders may also be considered.

Before the suitable plant growth material is redistributed, the regraded land should be scarified (ripped) to eliminate slippage surfaces and enhance root penetration. The redistribution of subsoil and topsoil, respectively, should then proceed in a manner that achieves an approximate uniform thickness consistent with the postmining land use(s) and prevents excess compaction of the spoils and suitable plant growth material.

Finally, nutrients (fertilizer) and soil amendments should be added to the surface soil layer in the amounts determined by soil tests. All soil analyses should be performed by a qualified laboratory using procedures approved by the Public Service Commission (North Dakota).

Selection of Adapted Plants

To comply with established State regulations, the mine operator will be required to establish on all disturbed areas a "diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area . . ." (Chapter 38-14.1, Section 69-05.2-22-01, North Dakota Century Code). Introduced species may be substituted for native species only if appropriate field trials have demonstrated that the introduced species are of equal or superior utility for the approved postmining land use(s), or are necessary to achieve a quick, temporary, and stabilizing cover. The Public Service Commission must approve the use of introduced species.

Some important considerations in selecting revegetative species for the Rattlesnake Butte Study Area should include: drought resistance, salt and sodium tolerance, resistance to winterkill, palatability, and resistance to grazing pressure. Of equal importance is plant compatibility with soil type, slope, aspect, and drainage conditions.

Table 1 lists the plants and seeding rates which are suggested for native grassland plantings, tame grass plantings (areas to be returned to cropland after 3-4 years), and salt affected soil plantings.[2/]

Seedbed Preparation and Planting

Suitable plant growth material is often compacted by heavy machinery during the redistribution process. To provide a plant medium favorable for air and water infiltration, as well as root penetration, the topsoil/subsoil should be chiseled to a depth of 18 to 24 inches prior to seedbed preparation. Disking/harrowing should then be conducted until a suitable seedbed is achieved.

2/ From: Guidelines for Reclaiming Coal Mine Lands; North Dakota Public Service Commision, 1976.

Seeding of grasses and legumes with a press drill is usually the preferred technique; however, broadcasting is also a widely accepted method. Drilling is considered superior because the seed is covered to a proper depth, rate of seeding is controlled, seed distribution is uniform, and soil compaction can be accomplished with packer wheels attached to the drill. Broadcasting is considered less efficient because the seeds often perch on top of the soil where germination and establishment are difficult. Seed that is broadcast should always receive some form of mechanical treatment to give it suitable coverage, unless the bed is loose so that natural sloughing of soil will cover the seed.[4/]

Natural woodland complexes (woody draws) occur to a minor extent in this study area. These complexes should be avoided during the mining operation, if at all possible, as they are irreplaceable ecosystems and the majority of the prairie animal community is dependent on them. If disturbance of these complexes cannot be avoided, the trees and shrubs should be salvaged for transplanting in reconstructed drainages.

Seeding and planting operations should be conducted during the first normal period for favorable planting conditions following the redistribution of suitable plant growth material. In the Rattlesnake Butte Study Area, early spring or late fall planting of grasses and legumes appears most desirable. If spring planting is selected, the plants should be seeded between early March and late April in order that seedlings may emerge before the spring rains begin. If late fall planting is chosen, seeding should be conducted after mid-October to prevent germination.

POST-RECLAMATION MANAGEMENT

Responsibility of the Mine Operator

In North Dakota, the coal mine operator will be responsible for management of the reclaimed area for a minimum of 10 years. The success of revegetation will then be determined for each approved postmining land use according to the following:[5/]

1. For rangeland and hayland, the following requirement must be achieved for the last two consecutive years of the responsibility period:

    (a) "Ground cover and productivity . . . shall be equal to or greater than, with 90 percent statistical confidence for herbaceous vegetation and 80 percent statistical confidence for woody vegetation, the approved standards[6/], and

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4/ USDA - Forest Service, General Technical Report INT-64, 1979.

5/ The postmining land uses in the Rattlesnake Butte Study Area are assumed to be rangeland, hayland, and cropland (small grains, corn, sunflowers).

6/ Approved standard refers to an undisturbed "reference" area chosen for comparative purposes to determine success of revegetation on the reclaimed site.

(b) The diversity, seasonality, and permanence of the vegetation . . . , determined from the major species and groups, shall be equivalent to that of the approved standard" (Chapter 38-14.1, Section 69-05.2-22-07(3)(a), North Dakota Century Code).

2. For cropland, "crop production . . . shall be equal to or greater than, with 90 percent statistical confidence, that of the approved standard for the last two consecutive growing seasons of the responsibility period" (Chapter 38-14.1, Section 69-05.2-22-07(3)(b), North Dakota Century Code).

On lands reclaimed to rangeland, livestock grazing "shall be practiced for at least the last 4 years of the responsibility period at a capacity approximately equal to that for similar well managed lands" (Chapter 38-14.1, Section 69-05.2-22-06, North Dakota Century Code). The Public Service Commission, in consultation with the landowner(s), will determine when the revegetated area is ready for livestock grazing.

Responsibility of the Landowner

The landowners in the Rattlesnake Butte Study Area will resume responsibility for management of the reclaimed lands following termination of the mine operator's responsibility period. To ensure that the reclaimed land remains stable and productive, the landowners should implement proper range and soil/crop management practices.

On areas returned to rangeland, grazing should be limited to a capacity that the reclaimed land is capable of supporting. Overgrazing reclaimed lands will result in a reduced vegetative cover, accelerated erosion, and an overall decrease in productivity.

On lands returned to cropland, the main objective of the landowner in cultivating the land should be sustained profitable production. To aid in achieving this objective, soil/crop management practices including contour tillage, fertilization, crop rotation, weed and insect control, mulching, etc., should be utilized whenever possible.

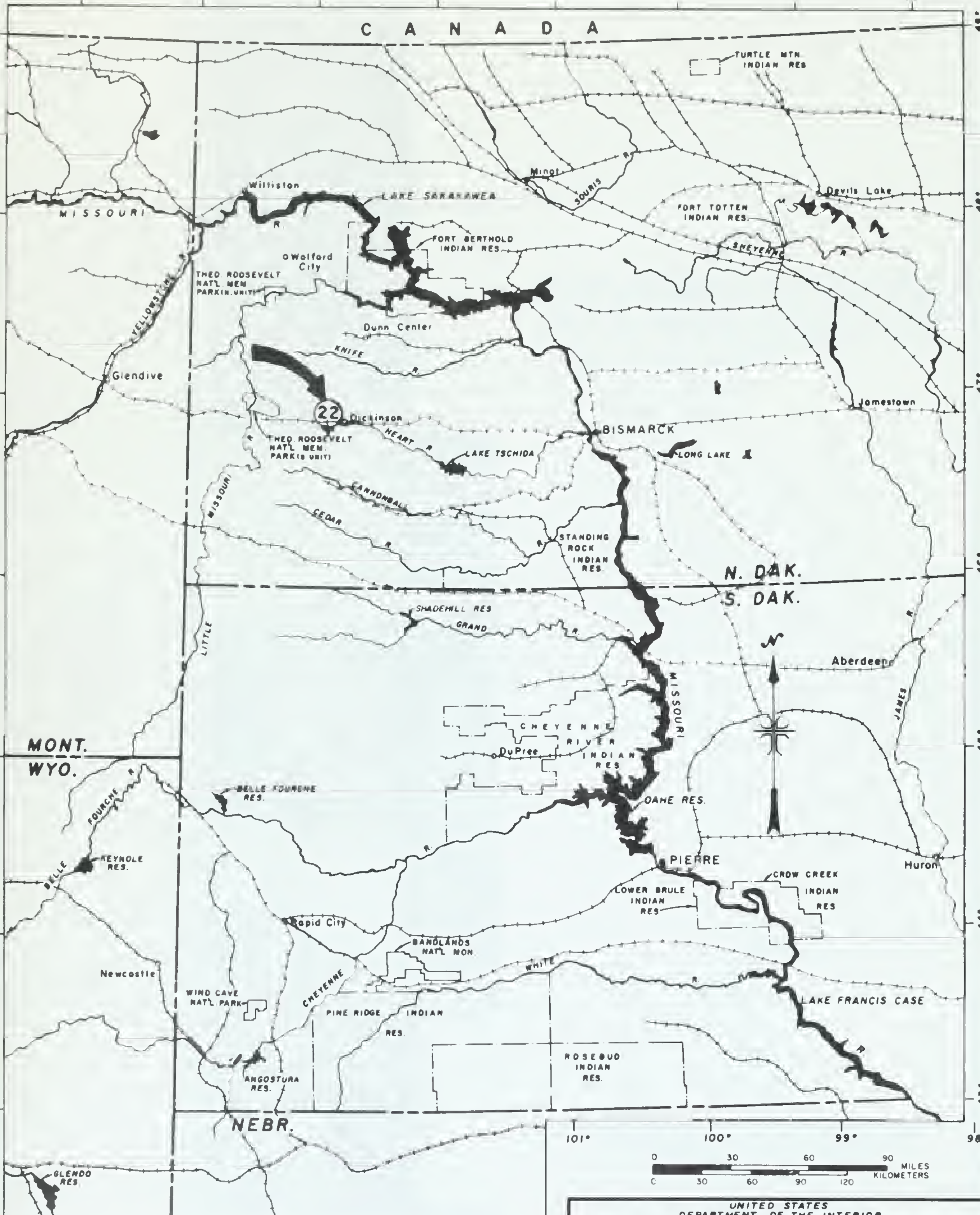
SUMMARY OF RECLAMATION POTENTIAL

Based on the resource data presented in this report, the potential for restoring surface-mined land in the Rattlesnake Butte Study Area to a condition capable of supporting the present uses (rangeland, hayland, and cropland) appears good. The most critical factors directly influencing revegetation: (1) climate, and (2) availability of suitable plant growth material, both appear favorable in this study area.

The climatic regime in this area is conducive to the production of native range plants, small grains, and other adaptable crops. The moisture

available to plants from snowmelt and spring precipitation is usually adequate for germination and establishment. Although the growing season in this area is estimated at 122 days between mid-to late-May and mid- to late-September, native grasses and small grains will typically mature or become dormant by about mid-July when the available soil moisture is depleted.

Most soils in this study area should yield about 6 to 12 inches (.15-.30m) of fair to good quality topsoil which is nonsaline, nonsodic, and moderately permeable. Given adequate moisture and a moderate amount of fertilization, this material should provide an excellent revegetative medium. Many of the soil profiles examined in the study area showed a marked increase in clay content, soluble salts, and/or exchangeable sodium in the subsurface horizons. Therefore, the quantity of suitable subsoil material available for replacement in the reconstructed profiles may be limited. Permeable material that is moderately saline may be utilized as subsoil in deficient areas. This material should leach and reclaim readily under natural conditions if placed over spoils with good internal drainage. Sodic or clay-rich materials should be selectively placed well below the root zone in reconstructed profiles.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RESOURCE & POTENTIAL RECLAMATION EVALUATION

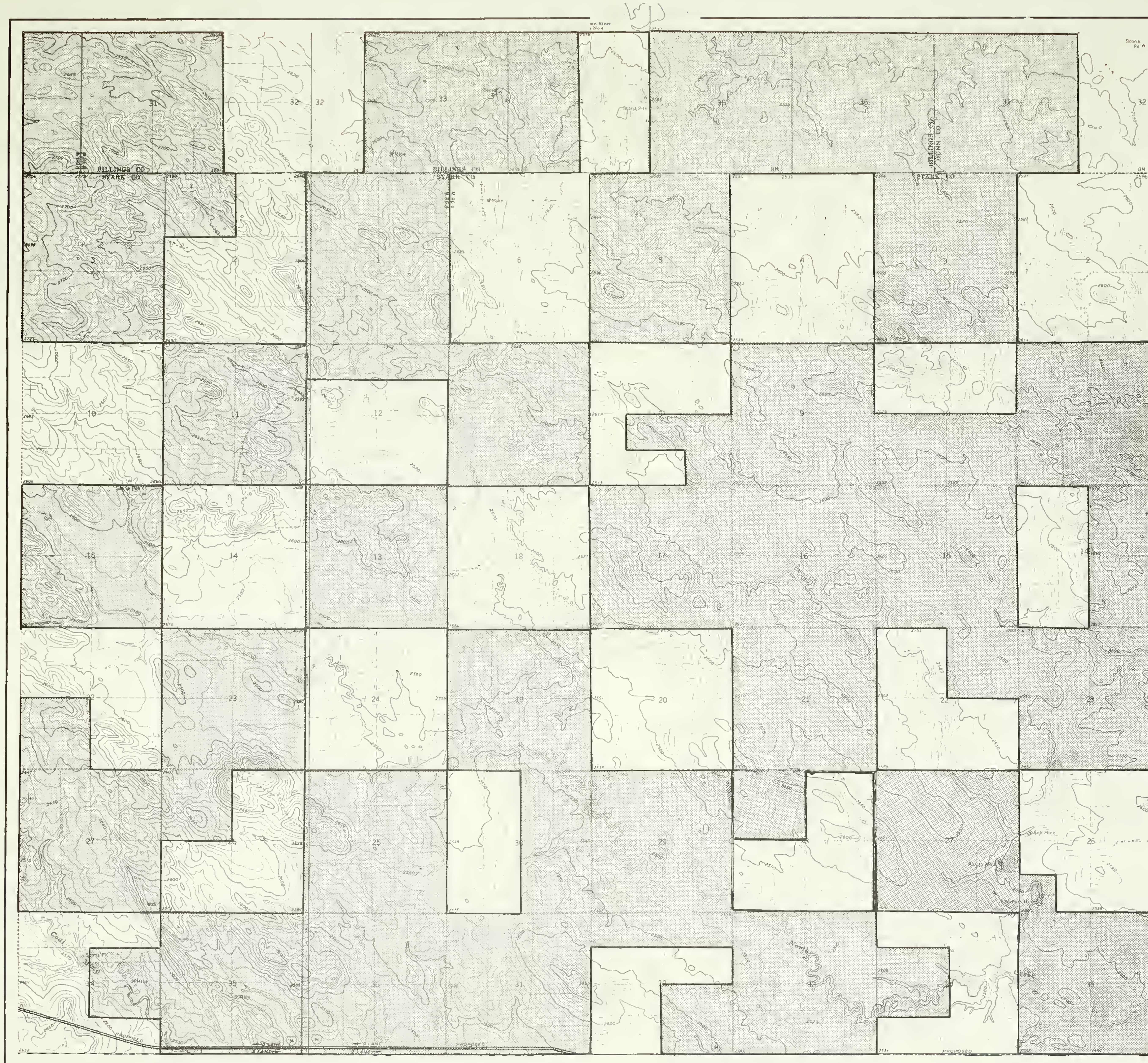
EMRIA STUDY AREAS
NORTH DAKOTA, SOUTH DAKOTA, MONTANA & WYOMING

GENERAL LOCATION MAP

DESIGNED Y. LINDSEN SUBMITTED
DRAWN Y. LINDSEN RECOMMENDED
CHECKED S.J.T. APPROVED

BILLINGS, MONTANA MARCH 1976 1305-600-244

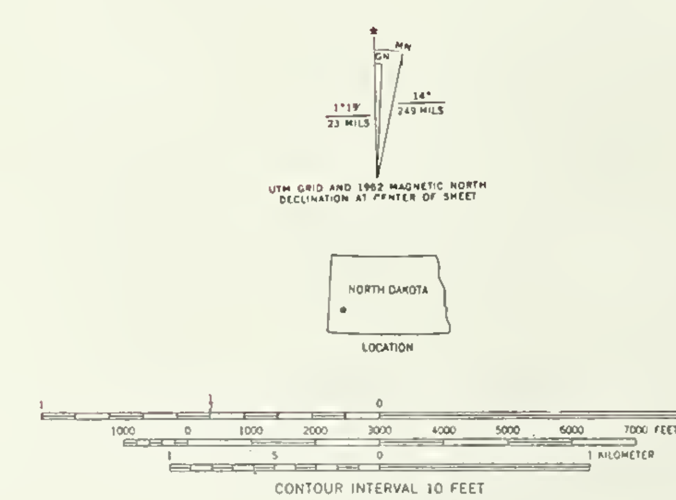
(22) RATTLESNAKE BUTTE STUDY AREA - EMRIA No. 22



NOTE

The land classification survey covers approximately 2250 additional acres along the north edge of the study area in all or part of Section 30, T. 141 N., R. 97 W., and sections 26, 28, and 30, T. 141 N., R. 98 W.

Study area not shaded.

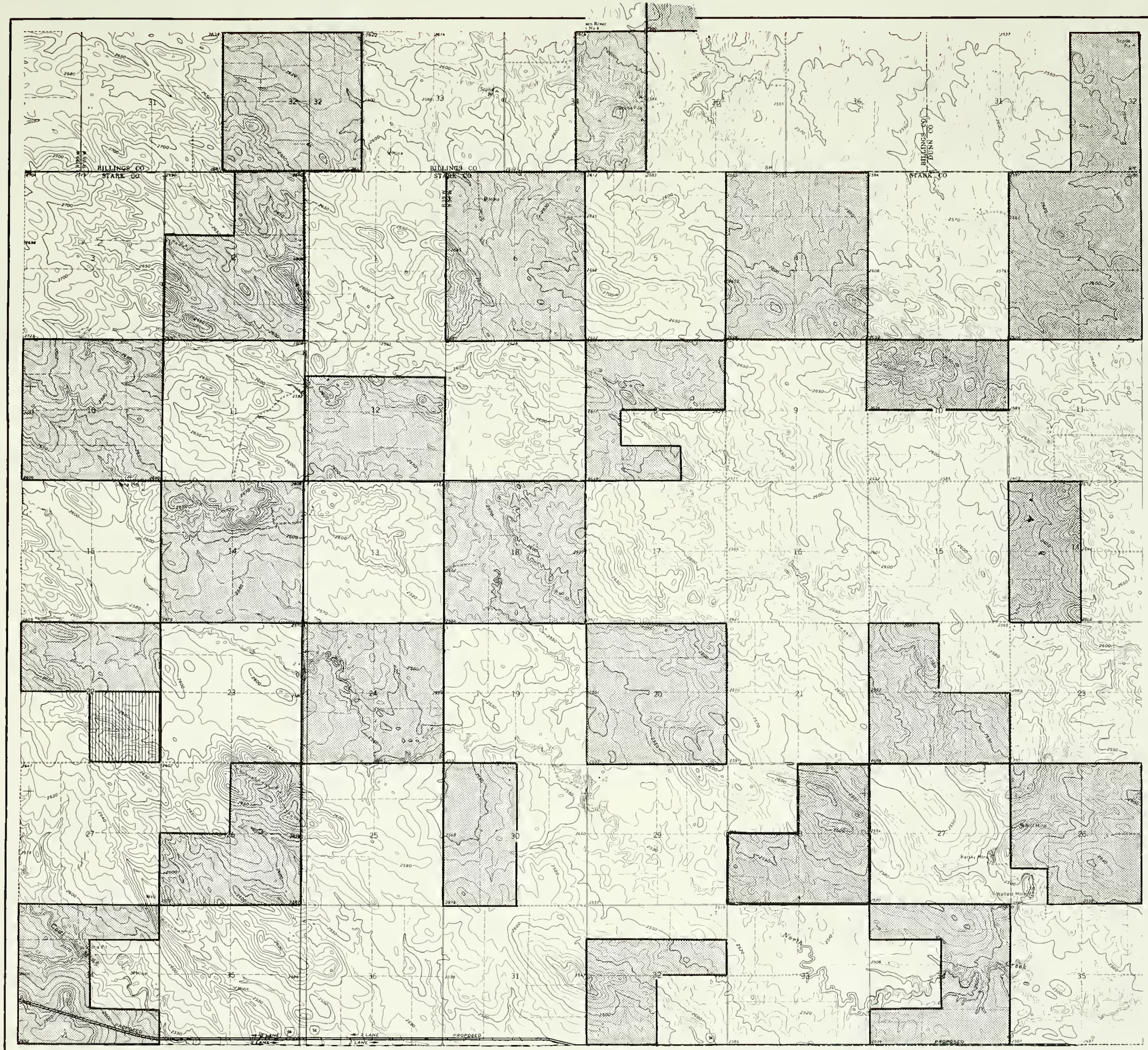


UNITED STATES
DEPARTMENT OF THE INTERIOR
WATER AND POWER RESOURCES SERVICE
RESOURCE AND POTENTIAL RECLAMATION EVALUATION

DICKINSON COALFIELD – NORTH DAKOTA
RATTLESNAKE BUTTE STUDY AREA

TOPOGRAPHY

DESIGNED L. PARISH	FIELD APPROVAL
DRAWN L E ALLSOP	TECHNICAL APPROVAL
CHECKED	APPROVED
BILLINGS, MONTANA MARCH, 1980	1305-600-245



MINERALS OWNED BY THE FEDERAL GOVERNMENT

COAL ONLY

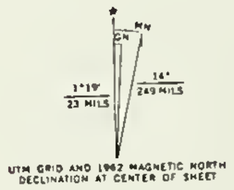
OTHER

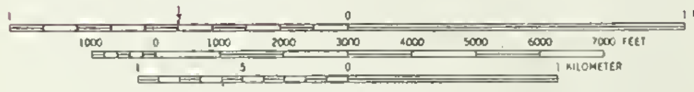
NOTES

All surface privately owned except the N 1/2 of Section 36, T. 141 N., R. 98 W. It is state owned.

Data from BLM Surface-Minerals Management Quad. SW-2

The land classification survey covers approximately 2250 additional acres along the north edge of the study area in all or parts of Section 30, T. 141 N., R. 97 W., and Sections 26, 28, and 30, T. 141 N., R. 98 W. The surface is privately owned but the coal is federally owned.





CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

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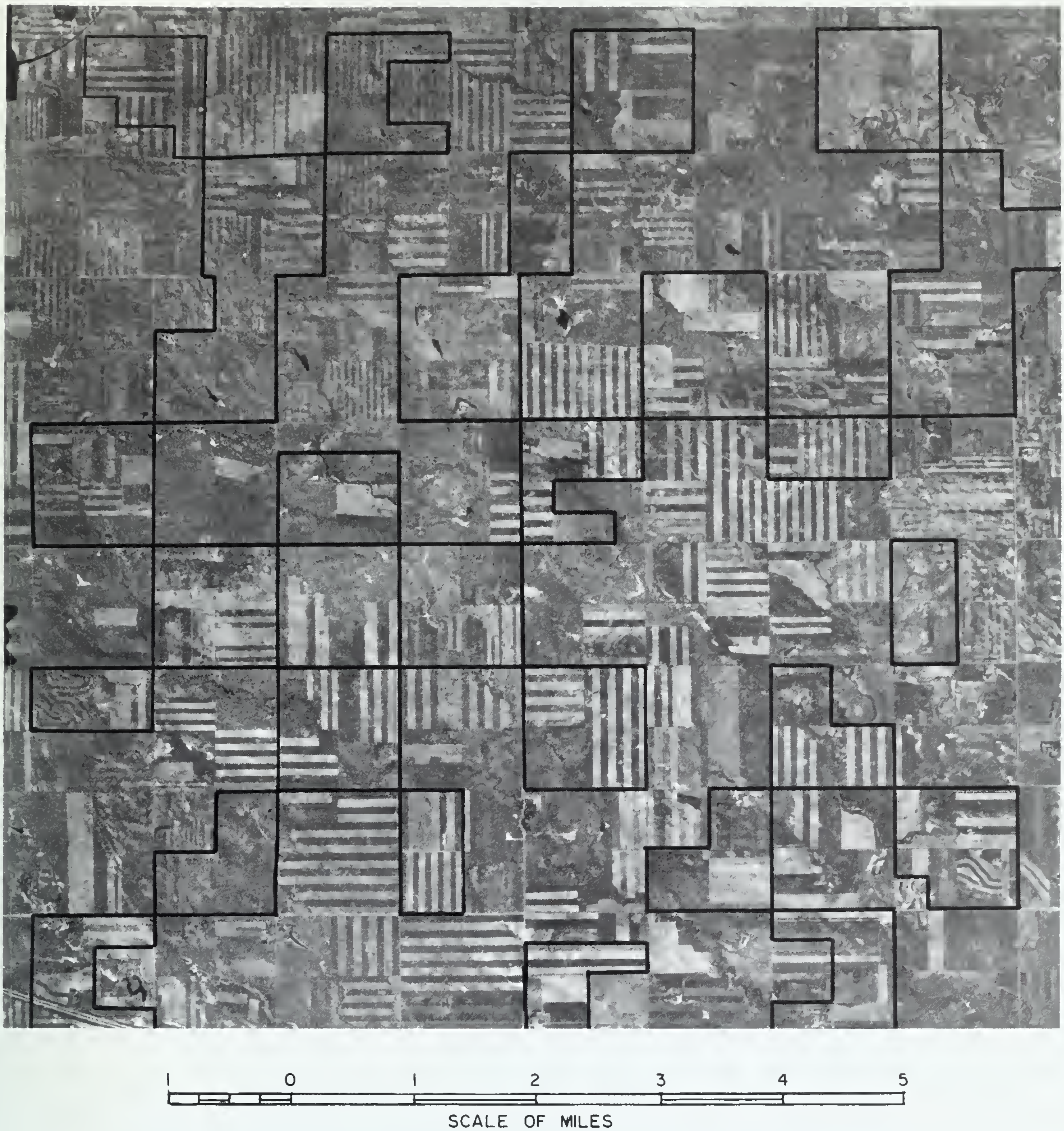
DICKINSON COALFIELD - NORTH DAKOTA
RATTLESNAKE BUTTE STUDY AREA

MINERAL STATUS MAP

DESIGNED L PARISH FIELD APPROVAL
DRAWN L E ALLSOP TECHNICAL APPROVAL
CHECKED APPROVED

BILLINGS MONTANA MARCH, 1981 | 05-600-246



Photograph 1 - Aerial view of the Rattlesnake Butte Study Area. This photograph is a portion of the Bureau of Land Management Surface-Minerals Management Quad. SW-2.

Table 1

NATIVE GRASSLAND PLANTINGS 3/

Species	Seeding Rate (lbs/acre)
Western wheatgrass	6
Pubescent wheatgrass*	1½
Little bluestem**	2
Sideoats grama	3
Green needlegrass	4
Alfalfa or	1
Sweetclover	½
Total	17-17½

* If seed not available, substitute slender wheatgrass.
** If seed not available, substitute prairie sandreed or switchgrass.

IMPROVED VARIETIES OF GRASS/LEGUME PLANTING FOR CROPLAND*

Species	Pasture or Hayland		Wildlife Planting
	Dry Site	Moist Site	
Crested wheatgrass	7	2	
Smooth bromegrass		5	
Pubescent wheatgrass**	3	3	
Intermediate wheatgrass			4
Tall wheatgrass			3
Alfalfa	1½	1½	3
Sweetclover	½	½	1
Total	12	12	11

* In pounds of seed per acre.
** If seed not available, substitute slender or intermediate wheatgrass.

SALT AFFECTED SOIL PLANTINGS

Species	Seeding Rate (lbs/acre)
Tall wheatgrass	4
Slender wheatgrass	3
Western wheatgrass	7
Sweetclover	2
Total	16

3/ Origin of native seed produced should be limited to North Dakota, South Dakota, eastern Montana, eastern Wyoming, and northern Nebraska.

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